Technology Innovation Project

Project Brief

TIP 269: Voltage Management: Voltage Instability Prediction (VIP) Approach

Context

There are more demands on transmission systems than ever before. More, varied generation is being interconnected; maintenance work has been compressed to minimize market impacts and avoid critical operational periods; and energy transfers continue to increase as power is bought and sold across the west coast to meet load and renewable clean-energy mandates.

During a real-time event, operating limits are reduced to a conservative level while changing system conditions are analyzed. The time it takes to develop new operating limits delays the customer's ability to resume access to the transmission system.

The BPA transmission system is typically voltage stability limited. Severe outages and grid disturbances in particular threaten the voltage stability of the system. The proposed pilot will deploy a real-time, model-free methodology to detect reactive power margin in real time for both dynamic and steady-state voltage stability conditions.

Description

Quanta Technology has teamed with Space-Time Insight to provide BPA with a real-time voltage management tool to be installed as a pilot project at BPA. The pilot will deploy a model-free methodology to detect reactive power margin in real-time for both dynamic and steady-state voltage stability conditions using EMS/SCADA and/or PMU data. It provides a next-generation visualization and situational awareness platform for voltage management, for a smarter, safer and more reliable infrastructure, allowing for more informed real-time decisions. The visualization and situational awareness part is comprised of four components:

- Geospatial visualization of voltage stability events
- Contextual dashboards that help understand threshold conditions
- Alerts and alarms that warn the operator of potential threshold violations
- A Rules Engine that enables the operator to set conditions based on PMU, EMS/SCADA and environmental conditions

This tool is much faster and simpler than the tools based on State Estimation and EMS contingency analysis that are presently available.

In comparison to existing real-time indices detecting voltage instability conditions, major improvements are achieved in accuracy, numerical stability, ease of use, and implementation variants. For example, it specifically addresses several implementation variants: bus, transmission line, transmission corridor, and load center. In addition, it is easily complements other methods and indices, such as reactive-power monitoring and model-based contingency analysis.

Why It Matters

This project will provide a tool to enhance Wide Area Situational Awareness by monitoring power stability reserves particularly related to voltage management. It will also serve as a basis for future applications involving intelligent alarms, remedial action schemes and future control and protection applications. It should provide a major tool for preventing wide area disturbances and supporting continuous deployment of renewable energy in the BPA system and for the WECC overall, with:

- Enhanced utilization of PMUs and smart SCADA devices for optimal, real-time checks of grid health.
- Intuitive display of key metrics describing the operating status of the electric grid; any telemetry that is readily available for these real-time systems.
- Advanced monitoring and display of the communication infrastructure and providing visual status and alerts based on BPA defined Key metrics, such as bandwidth, router status, packet drop, etc.

Improved grid stability, reduced business, economic and social disruption, and better utilization of renewable generation are the results.

Goals and Objectives

The objective of this project is to develop, implement and test a working prototype of the VIP application with full-scale wide-area visualization applied to the Pacific Northwest transmission network under BPA control. In addition to reports and briefs, key actions will ensue:

- A comprehensive comparative review of existing voltage management techniques focusing on the ability to monitor system dynamics in real-time.
- Complete comparison of various versions of Voltage instability prediction (VIP) algorithms with respect to real-time monitoring of voltage stability/power margins and ability to enable stability controls, protection and alarming.
- Comprehensive testing and demonstration of the method with simulated and actual field data.

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Project Start Date: October 1, 2012

Project End Date: September 30, 2014

Funding

Total Project Cost:	$756,000
BPA Share:	$375,000
External Share:	$381,000
BPA FY2013 Budget:	$212,500

Reports & References (Optional)

Links (Optional)

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Participating Organizations

Quanta Technology, LLC
Space Time Insight (STI)